Analog Electronic Circuits
Department of Electrical and Computer Engineering
Seoul National University

Midterm Exam

October 26, 2020 D.K. Jeong

A sheet of one-sided, A4-size note is allowed.

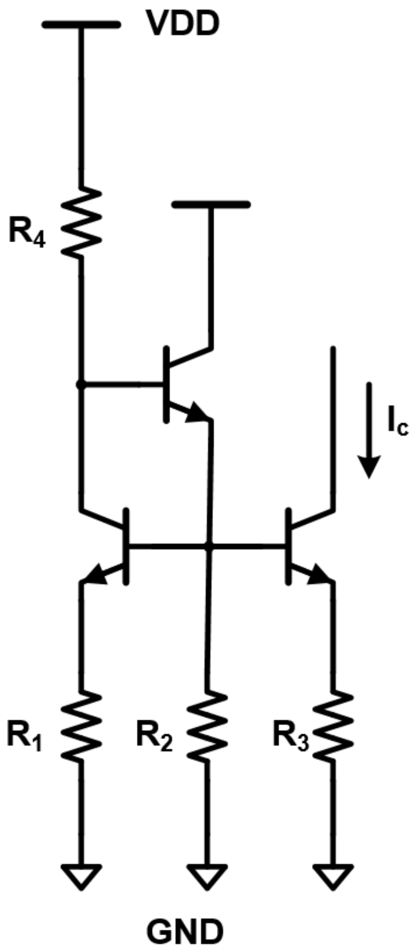
Roster Number (학번):

Name:

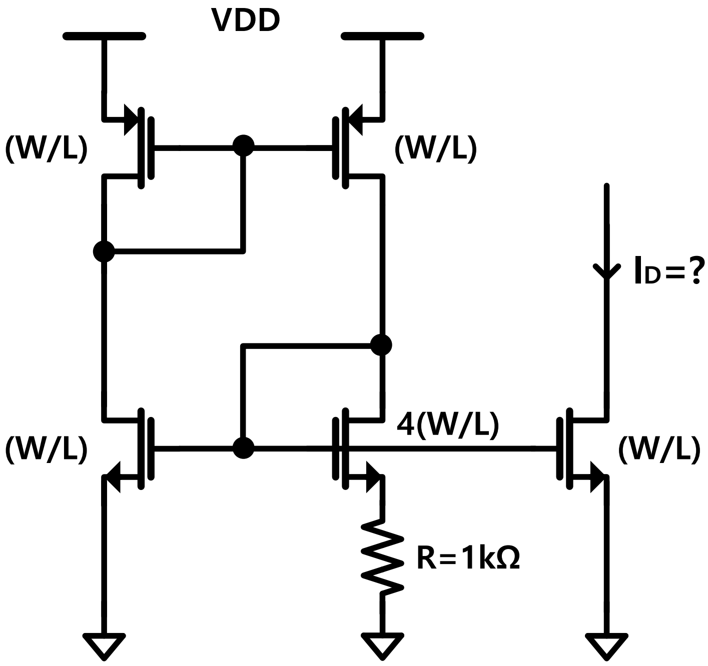
Signature:

Problem	**Max Score**	**Score**
1	10	
2	10	
3	10	
4	10	
5	20	
6	20	
7	20	
Total	100	

[1] Find the values of I_c. Assume that $R_1 = 1\text{k}\Omega$, $R_2 = 10\text{k}\Omega$, $R_3 = 1\text{k}\Omega$, $R_4 = 10\text{k}\Omega$, V_{BE}= 0.7V, $\beta = \infty$, and V_{DD} = 10V.



[2] Find the value of I_D. Assume that $(\frac{W}{L}) = 10$, $\mu_n C_{OX} = \mu_p C_{OX} = 200\ \mu A/V^2$, $V_{th}=0.5V$, $\lambda=0$, and V_{DD} = 2V.



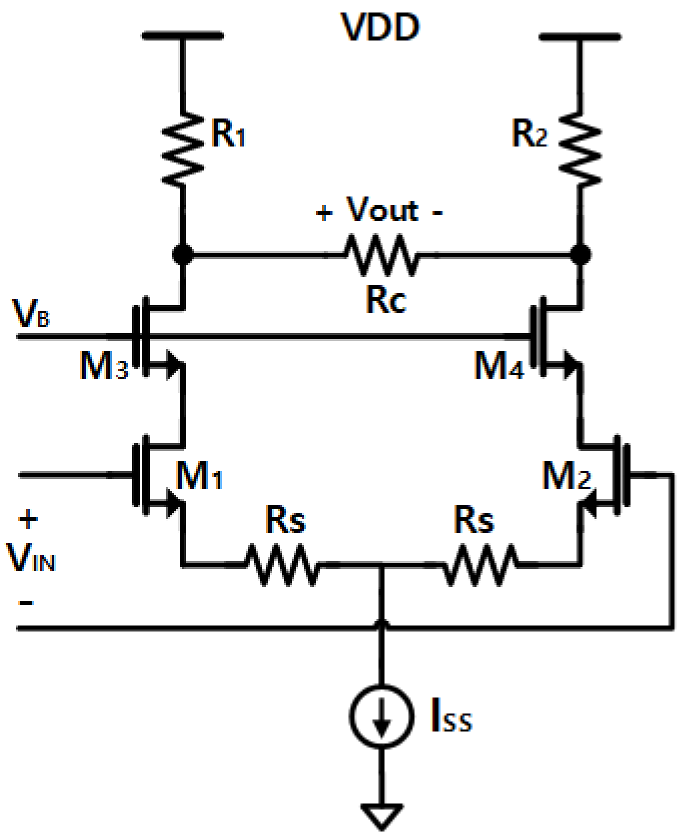
[3] For the following circuit, answer the questions.

Assume the circuit is symmetric and all MOS transistors are in the **saturation** region.

(Use $R_1=R_2=5k\Omega$, $R_C=20k\Omega$, $R_S=1k\Omega$, $V_{DD}=5V$, I_{SS} = 1mA, V_{thn} = 0.4V,

$g_{m1} = g_{m2}$ =1 mA/V, neglect the channel legnth modulation. M_1,M_2,M_3 and M_4 are ideally identical.

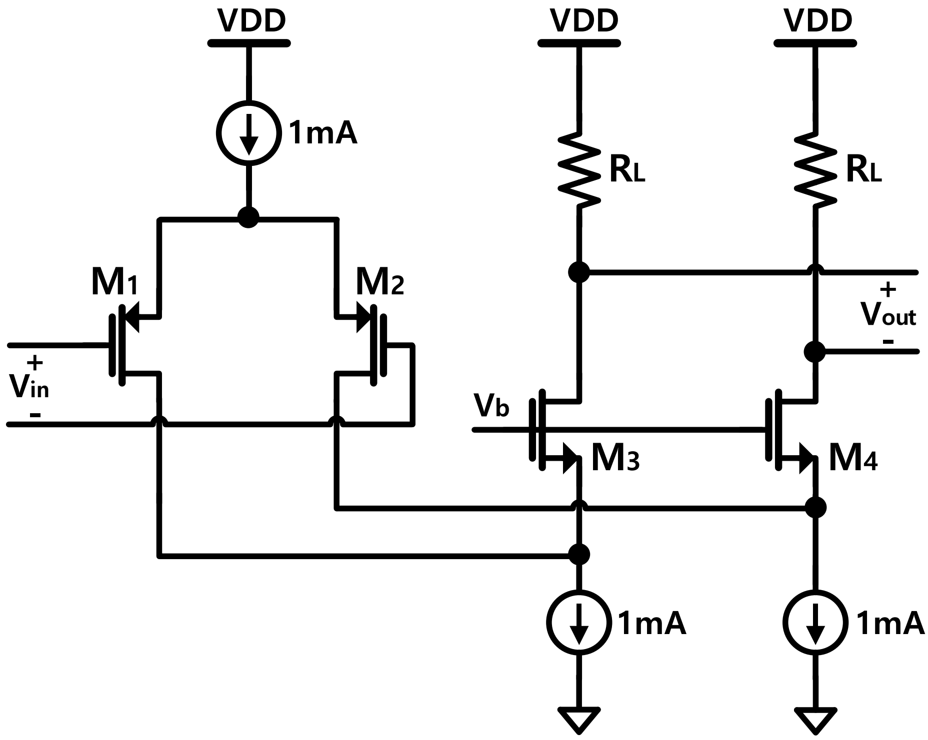
The V_{IN} is the small signal with common mode voltage($V_{IN,CM}$=2V).)



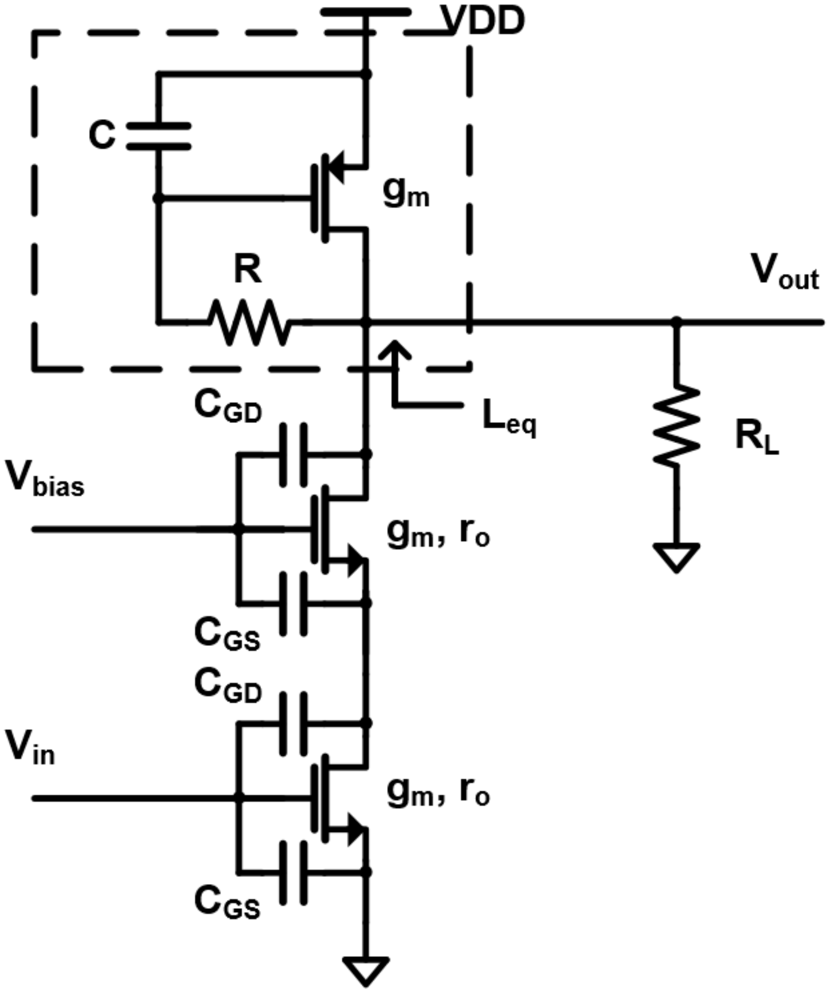
A. Find the V_B with the widest dynamic range of output.

B. Derive the expression of small-signal differential voltage gain from V_{in} to V_{out}.
Consider the channel length modulation. There is no need to find a value.

[4] Find the small signal gain $A_v (= \frac{V_{out}}{V_{in}})$. Assume that all transistors have the same $(\frac{W}{L})$ of 20, $\mu_n C_{OX} = 200 \mu A/V^2$, $\mu_p C_{OX} = 100 \mu A/V^2$, V_{th}=0.5V, $\lambda_n = 0.01V^{-1}$, $\lambda_P = 0.02V^{-1}$, R_L=2kΩ, and V_{DD} = 5V. Also assume that all MOS transistors are in the **saturation** region.



[5] For the following active inductor circuit, answer the questions.

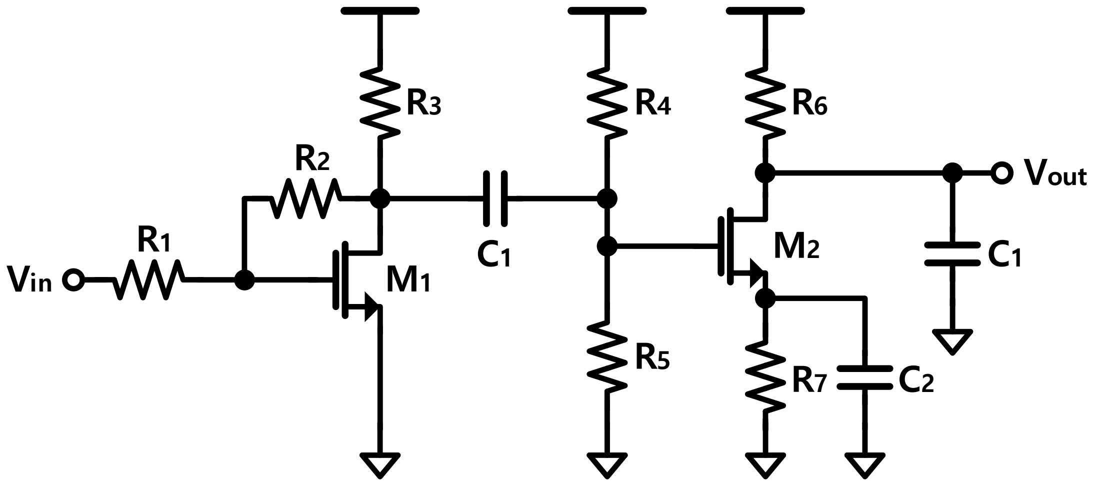


A. Find L_{eq} of the active inductor.

B. Find the frequency range where the active inductor becomes purely inductive.

C. Find the transfer function of the above circuit.

[6] For the following circuit, find the transfer function H(s) of the circuit and draw a Bode plot of H(s). Assume that $R_1=R_2=R_3=1k\Omega$, $R_4=R_5=100k\Omega$, $R_6=2.5k\Omega$, $R_7=1k\Omega$, $C_1=2pF$, $C_2=4pF$, $C_3=4pF$, $g_{m1}=2mS$, $g_{m2}=4mS$.



[7] Fill in the table. Assume that $g_m = \infty$.

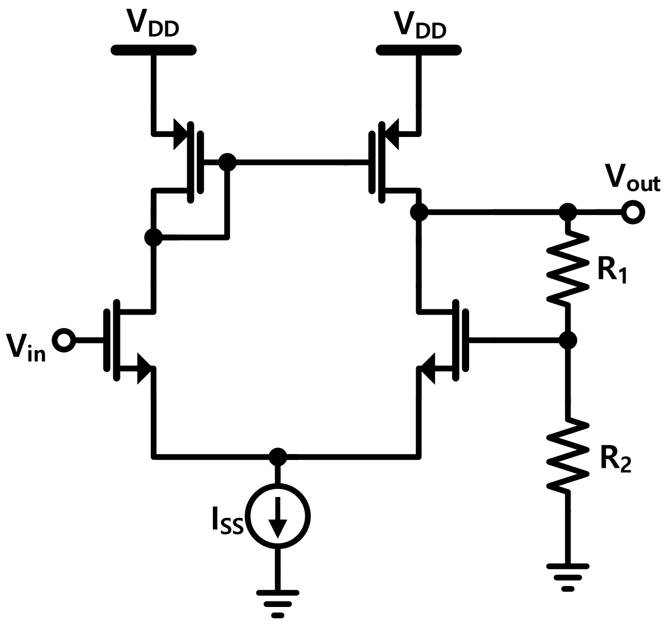


Fig A

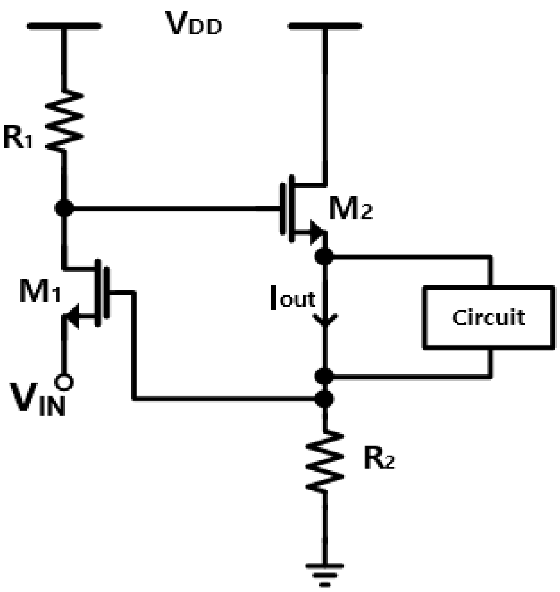


Fig B

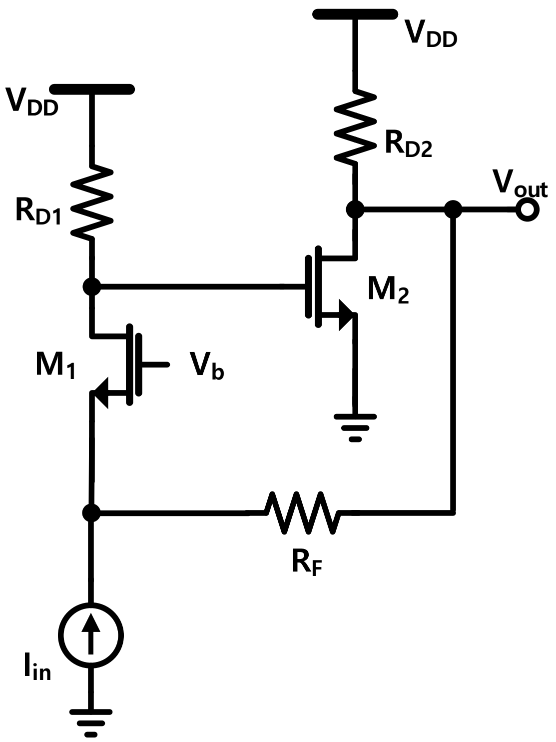


Fig C

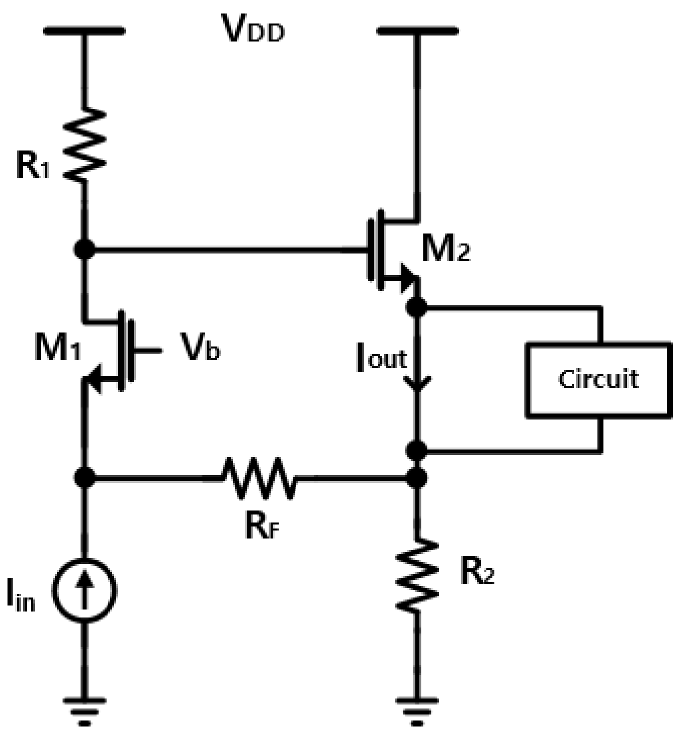


Fig D

	Fig A	Fig B	Fig C	Fig D
Feedback Topology	Voltage to Voltage			
Type of Amplifier				Current Amplifier
Open-loop Gain	∞	∞		
Feedback Factor	$\frac{R_2}{R_1 + R_2}$			
$R_{in\text{-}open}$			0	0
$R_{in\text{-}closed}$	∞		0	
$R_{out\text{-}open}$		R_2		
$R_{out\text{-}closed}$	0		0	

{End of Midterm }